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Indian Standard

SPECIFICATION FOR ALUMINIUM ELECTROLYTIC CAPACITORS WITH NON-SOLID ELECTROLYTE

(Second Revision)

UDC 621·319·45 [669·71] : 620·1

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SPECIFICATION FOR ALUMINIUM ELECTROLYTIC CAPACITORS WITH NON-SOLID ELECTROLYTE

(Second Revision)

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Indian Standard

SPECIFICATION FOR ALUMINIUM ELECTROLYTIC CAPACITORS WITH NON-SOLID ELECTROLYTE

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 22 June 1983, after the draft finalized by the Capacitors Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard was originally published in 1967 and subsequently revised in 1977. It is now being revised again in light of the experience gained and the implementation difficulties faced by the industry.

0.3 It was earlier envisaged to prepare this standard in different parts so that the detail requirements of individual types of electrolytic capacitors could be covered in subsequent parts. However, it has now been decided that all the requirements for various categories of aluminium electrolytic capacitors would be covered in one standard and there would be no subsequent parts to this standard.

0.4 The object of this standard is to prescribe standard ratings and characteristics, select from IS : 7305 (Part 1)-1973* the appropriate methods of tests and to give requirements for aluminium electrolytic capacitors with non-solid electrolyte.

0.5 While preparing this standard, assistance has been derived from the following:

IEC Pub 384-4 (1977)	Aluminium electrolytic capacitors with solid or non-solid electrolyte, selection of methods of tests and general requirements, issued by the International Electrotechnical Commission (IEC).

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*Specification for fixed capacitors used in electronic equipment : Part 1 General requirements and tests.

JSS : 50207 Detail specification for capacitors, fixed, electrolytic with aluminium electrodes, Directorate of Standardization, Department of Defence Production, Ministry of Defence, New Delhi.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard applies to polar aluminium electrolytic capacitors with non-solid electrolyte. It comprises capacitors for long life and general purpose applications.

1.1.1 Additional requirements for capacitors meant for special applications such as coupling and de-coupling at higher frequencies, photo flash, etc, are not covered in this standard. These shall be as agreed upon between the purchaser and the manufacturer.

2. TERMINOLOGY

2.1 For the purpose of this standard, the following definitions in addition to those given in IS : 7305 (Part 1)-1973† shall apply.

2.1.1 *Capacitance of an Electrolytic Capacitor* — The capacitance of an equivalent circuit having capacitance and resistance in series measured with alternating current of approximately sinusoidal wave form of the specified frequency.

2.1.2 *Long Life Grade Capacitors* — Capacitors intended for applications where a high degree of stability of characteristics over a long life is essential.

NOTE — The materials are so chosen and the manufacture so carried out that improved performance is obtained with consequent increase in life.

2.1.3 *General Purpose Grade Capacitors* — Capacitors intended for applications where the high performance level of long life grade capacitors is not required.

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*Rules for rounding off numerical values (*revised*).

†Specification for fixed capacitors used in electronic equipment : Part 1 General requirements and tests.

2.1.4 *Reverse Voltage (for Polar Capacitors only)* — A voltage applied to the capacitor terminal in the reverse polarity direction.

3. CLIMATIC CATEGORIES

3.1 The aluminium electrolytic capacitors covered by this standard are classified into climatic categories according to the general rules given in IS : 589-1961*. The preferred severities for dry heat, cold and damp heat tests shall be chosen from among the following:

Tests	*Severities*
Dry heat	+70°C to +125°C
Cold	—25°C to —55°C
Damp heat	21 days, 56 days

The recommended classification is given below:

Climatic Test	*Severities*				
	Category 1		Category 2		Category 3
	1A	1B	2A	2B	
Dry heat	+105°C	+85°C	+85°C	+70°C	+70°C
Cold	—55°C	—55°C	—40°C	—25°C	—25°C
Damp heat (long term)	56 days	56 days	56 days	56 days	21 days
Damp heat (accelerated)	6 cycles	6 cycles	6 cycles	6 cycles	2 cycles
Rapid change of temperature	+105°C to —55°C	+85°C to —55°C	+85°C to —40°C	+70°C to —25°C	+70°C to —25°C
Low air pressure	2 kPa	2 kPa	2 kPa	2 kPa	8·5 kPa

NOTE — The recommended applications for above categories shall be as follows:

Category 1A and 1B (Long Life Grade only)	—	Defence/industrial applications
Category 2A and 2B (General Purpose Grade/ Long Life Grade)	—	Industrial/commercial applications
Category 3 (General Purpose Grade only)	—	Industrial/commercial applications

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

4. RATINGS

4.1 The values for the ratings and characteristics of aluminium electrolytic capacitors covered by this standard shall preferably be selected from those specified in **4.2** to **4.8**.

4.2 Rated Voltage (U_R) — The values of rated direct voltages taken from the R5 and R10 series of IS : 1076-1967* shall be :

For values of $U_R \leq 250$ V	1, 1·6, 2·5, 3·5, 4, 5, 6·3 V and their decimal multiples (R5 series)
For values of $U_R \geq 250$ V	250, 315, 350, 400, 450, 500 V (250, 315 and 400 V are in accordance with the R10 series, 350 and 450 V are permitted in addition, on account of their wide usage in current practice)

4.3 Category Voltage (Uc) — Unless stated otherwise, the category voltage shall be equal to the rated voltage.

4.4 Reverse Voltage — The permissible reverse voltage shall be 10 percent of the rated voltage for rated voltage up to 10 V and 1 V for rated voltage above 10 V.

4.5 Surge Voltage Ratio — The surge voltage shall be 1·15 times the rated voltage for rated voltage up to 315 V or 1·1 times the rated voltage for rated voltages above 315 V.

4.6 Rated Ripple Current — The rated ripple current for general purpose grade at 85°C and 70°C and at 100 Hz shall be as given in Table 1 for both axial lead type capacitors and radial lead type capacitors.

NOTE — The rated ripple current for upper category temperature of 105°C is under consideration.

TABLE 1 RATED RIPPLE CURRENT

RATED VOLTAGE (1)	CAPACITANCE (2)	RMS RIPPLE AT 85°C AND 100 Hz, *Max* (3)	RMS RIPPLE AT 70°C AND 100 Hz, *Max* (4)
V dc	µF	mA	mA
6·3	0·47	5	—
	1·0	8	—

(*Continued*)

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*Preferred numbers (*first revision*).

TABLE 1 RATED RIPPLE CURRENT — *Contd*

RATED VOLTAGE (1) V dc	CAPACITANCE (2) μF	RMS RIPPLE AT 85°C AND 100 Hz, *Max* (3) mA	RMS RIPPLE AT 70°C AND 100 Hz, *Max* (4) mA
	2·2	12	—
	3·3	15	—
	4·7	18	—
	10	25	—
	22	38	—
	33	50	—
	47	65	—
	100	110	—
	220	215	340
	330	265	420
	470	315	500
	1 000	550	870
	2 200	860	1 360
	3 300	1 100	1 740
	4 700	1 400	2 210
	6 800	1 600	—
	10 000	2 000	—
10	0·47	6	—
	1·0	9	—
	2·2	13	—
	3·3	16	—
	4·7	19	—
	10	30	—
	22	45	—
	33	55	85
	47	65	100
	100	120	190
	220	215	340
	330	285	450
	470	380	600
	1 000	580	915
	2 200	1 050	1 660
	3 300	1 350	2 135
	4 700	1 600	2 530
	6 800	2 000	—
	10 000	2 300	—
16	0·47	6	—
	1·0	9	—
	2·2	14	—
	3·3	17	—
	4·7	20	—
	10	35	—
	22	45	70
	33	55	85
	47	80	125
	100	160	250

(Continued)

TABLE 1 RATED RIPPLE CURRENT — *Contd*

RATED VOLTAGE (1) V dc	CAPACITANCE (2) µF	RMS RIPPLE AT 85°C AND 100 Hz, *Max* (3) mA	RMS RIPPLE AT 70°C AND 100 Hz, *Max* (4) mA
	220	250	395
	330	350	555
	470	400	635
	1 000	700	1 105
	2 200	1 120	1 770
	3 300	1 500	2 370
	4 700	1 800	2 845
	6 800	2 000	—
	10 000	2 500	—
25	0·47	7	—
	1·0	10	—
	2·2	15	—
	3·3	18	—
	4·7	25	—
	10	40	60
	22	50	80
	33	75	120
	47	85	135
	100	170	270
	220	320	505
	330	410	650
	470	525	830
	1 000	900	1 420
	2 200	1 300	2 055
	3 300	1 650	2 610
	4 700	2 100	3 320
	6 800	2 200	—
35	0·47	7	—
	1·0	11	—
	2·2	16	—
	3·3	20	—
	4·7	25	40
	10	40	60
	22	70	110
	33	75	120
	47	120	190
	100	180	285
	220	330	520
	330	415	655
	470	540	855
	1 000	910	1 440
	2 200	1 600	2 430
	3 300	1 800	2 845
	4 700	2 200	3 475

(*Continued*)

TABLE 1 RATED RIPPLE CURRENT — *Contd*

RATED VOLTAGE (1) V dc	CAPACITANCE (2) µF	RMS RIPPLE AT 85°C AND 100 Hz, *Max* (3) mA	RMS RIPPLE AT 70°C AND 100 Hz, *Max* (4) mA
50	0·47	6	—
	1·0	13	—
	2·2	20	—
	3·3	25	40
	4·7	35	55
	10	45	70
	22	90	140
	33	110	175
	47	130	205
	100	245	385
	220	390	615
	330	540	855
	470	750	1 185
	1 000	1 200	1 895
	2 200	1 800	2 845
	3 300	2 000	3 160
63	0·47	6	—
	1·0	13	—
	2·2	20	35
	3·3	25	40
	4·7	35	55
	10	50	80
	22	100	160
	33	120	190
	47	150	235
	100	260	410
	220	450	710
	330	630	995
	470	800	1 265
	1 000	1 400	2 215
	2 200	2 000	3 160

4.7 Rated Capacitance — The value of rated capacitance shall be in accordance with E6 series of IS : 824-1965*. These values are:

> *1*, 1.5, *2.2*, 3.3, *4.7* and 6.8 and their decimal multiples (italicized values being preferred).

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*Preferred values for resistors and capacitors (*revised*).

4.8 Tolerance on Rated Capacitance — The values of tolerances on rated capacitance shall be as given below:

±10 percent

$^{-10}_{+30}$ percent

$^{-10}_{+50}$ percent

$^{-10}_{+75}$ percent

±20 percent

5. CONSTRUCTION AND WORKMANSHIP

5.1 The construction and workmanship shall be in accordance with 5 of IS : 7305 (Part 1)-1973*.

6. DIMENSIONS

6.1 The dimensions shall be specified by the manufacturers. Some of the commonly used CAN sizes are given below:

Diameter × *Length* (mm)		
5 × 12 (11·5)	10 × 12	16 × 35
6·3 × 12	10 × 20	16 × 40
8 × 12	12·5 × 25	18 × 40
8 × 16	16 × 25	22·4 × 40
8 × 20	16 × 31	22·4 × 50

7. MARKING AND PACKAGING

7.1 Marking

7.1.1 The capacitors shall be clearly marked at least with items a), b), c) and with as many of the remaining items as practical.

a) Rated capacitance in microfarads

NOTE — When values and tolerances are coded, one of the methods specified in IS : 8186-1976† should be used.

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*Specification for fixed capacitors used in electronic equipment : Part 1 General requirement and tests.

†Marking codes for values and tolerances of resistors and capacitors.

b) Rated voltage, direct voltage may be indicated by symbol '——' or 'DC'.

c) Polarity of the terminations.

NOTE — For multisection capacitors, the rated capacitance and rated voltage of the sections connected to each termination shall be shown in an unambiguous way. The termination of a section which is intended for direct connection to the rectifier (so-called reservoir section) shall be marked with the number 1 or with colour red.

d) Tolerance on rated capacitance [*see* note under **7.1.1 (a)**].

e) Reference to the grade.

NOTE 1 — For marking purposes, the following abbreviations may be used:

Long Life Grade — LL, and
General Purpose Grade — GP.

NOTE 2 — If no specific marking is made, it implies general purpose.

f) Rated ripple current.

g) Appropriate climatic category.

h) Style reference.

j) Manufacturer's name or trade-mark.

k) Year and month (or week) of manufacture in accordance with IS : 8186-1976*; and

m) Manufacturer's type designation.

7.1.2 The package containing the capacitor(s) shall be clearly marked with all the information listed in **7.1**(a) to (d), as far as possible.

7.1.3 The capacitors may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

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*Marking codes for values and tolerances of resistors and capacitors.

7.2 Packaging

7.2.1 Recommended guidelines for tape packaging of aluminium electrolytic capacitors, so as to facilitate assembly or automatic insertion, are given in Appendix A (for capacitors with axial leads) and Appendix B (for capacitors with unidirectional leads).

8. TESTS

8.1 Classification of Tests

8.1.1 *Type Tests*

8.1.1.1 *Type approval procedure* — The procedure for type approval shall be in accordance with IS : 2612-1965[*].

8.1.1.2 *Number of samples* — Unless otherwise specified, the number of samples for each type shall be 31.

8.1.1.3 *Selection of samples* — The samples shall be representative of the range of values of the type under consideration. Samples shall comprise quantities as equal as possible of the largest and the smallest case size specimens with the lowest and the highest rated voltages. When there are more than four case sizes, and intermediate case size shall also be tested. For each case size, the specimens with the highest capacitance shall be chosen.

NOTE — A capacitor subjected to type tests shall not be used in equipment nor be returned to bulk supply.

8.1.1.4 *Schedule of type tests* — The schedule of type tests and number of samples shall be as given in Table 2.

---

[*] Recommendation for type approval and sampling procedures for electronic components.

TABLE 2 SCHEDULE OF TESTS

(*Clause* 8.1.1.4)

GROUP	NO. OF SAMPLES OF HIGHEST CAPACITANCE VALUE IN EACH VOLTAGE	TITLE OF TEST	CLAUSE REF
(1)	(2)	(3)	(4)
0	31	Visual examination Dimensions Capacitance Tengent of loss angle Impedance (if required) Leakage current Voltage proof (where applicable) Insulation resistance (where applicable) Sealing (where applicable)	8.4.1 8.4.2 8.3.2 8.3.3 8.3.4 8.3.1 8.3.6 8.3.5 8.5.1.2
1	6	Solderability Robustness of terminations Bump Vibration Shock* Rapid change of temperature Climatic sequence	8.4.4.1 8.4.3 8.4.6 8.4.5 8.4.7 8.5.3 8.5.1
2	6	Damp heat (long term)	8.5.2
3	6	Endurance	8.8
4	2	Storage Mould growth	8.7 8.5.4
5	3	Resistance to solvents Resistance to soldering heat	8.5.6 8.4.4.2
6	4	Characteristics at low and high temperature Surge voltage Salt mist*	8.6 8.3.7 8.5.5
7	2	Pressure relief (for vent type only)	8.4.8
Spares	2		

*Not applicable to General Purpose Grade (GP).

8.1.2 *Routine Tests* — The following shall constitute routine tests:

a) Visual examination (**8.4.1**),
b) Voltage proof (for two seconds) (**8.3.6**),
c) Capacitance (**8.3.2**), and
d) Leakage current (**8.3.1**).

8.1.3 *Acceptance Tests* — Two groups of samples (Group A and Group B) shall be selected from the lot which have passed the routine tests; and the capacitors shall be subjected to the tests in the order given in Table 3.

TABLE 3 SCHEDULE OF ACCEPTANCE TESTS

TEST (1)	CLAUSE REF (2)	AQL (PERCENT DEFECTIVE) (3)	INSPECTION* (4)	D/ND (5)
Group A Tests				
Dimensions	8.4.2	1 percent	II	*ND*
Voltage proof (for 2 seconds)	8.3.6			
Tangent of the loss angle	8.3.3			
Impendance (if required)	8.3.4			
Group B Tests				
Sub-group I				
Endurance (168 h)	8.8	4 percent	S3	*ND*
Sub-group II				
Robustness of terminations	8.4.3	4 percent	S3	*D*
Solderability	8.4.4.1			
Bump	8.4.6			
Climatic sequence	8.5.1			

**See* IS : 10673-1983 'Sampling plans and procedures for inspection by attributes for electronic items'.

D = Destructive. *ND* = Non-destructive.

8.2 General Conditions for Tests — The general conditions for tests shall be specified in **7.2** of IS : 7305 (Part 1)-1973* in addition to the following.

8.2.1 *Preconditioning* — Before starting the test programme, all capacitors shall be preconditioned by the application of the rated voltage from a direct voltage source having low internal resistance such as a regulated power supply. The voltage shall be applied to the capacitor through a series resistor, the value of which shall be approximately 100 Ω for rated voltage up to and including 100 V and approximately 1 000 Ω for rated voltage above 100 V.

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* Specification for fixed capacitors used in electronic equipment : Part 1 General requirements and tests.

The voltage shall be maintained for one hour after its value across the capacitor has become equal to the rated voltage with a tolerance of ±3 percent. After this preconditioning the capacitors shall be discharged through a resistor of approximately 1 ohm per applied volt.

The tests in **8.3** shall then be made after the capacitors have been stored for a period of 12 hours to 48 hours during which no voltage shall be applied. No further preconditioning as described above shall be applied during the test programme.

8.3 Electrical Tests

8.3.1 *Leakage Current* — This test shall be carried out in accordance with **7.3.4** of IS : 7305 (Part 1) - 1983* except as modified by **8.3.1.1** and **8.3.1.2**.

8.3.1.1 *Measuring conditions* — The rated voltage shall be applied across the capacitor and its protective resistor for 5 minutes before test. The protective resistor shall be approximately 100 Ω for rated voltage ⩽ 100 V and approximately 1 000 Ω for rated voltage > 100 V.

8.3.1.2 *Requirements* — The leakage current shall not exceed the following values :

CV Product in μ Coulomb	*Leakage Current in μA*	
	Long Life Grade	General Purpose Grade
⩽ 1 000	0·01 CV or 1 μA whichever is greater	0·05 CV or 5 μA whichever is grater
> 1 000	0·006 CV+4 μA	0·03 CV+20 μA

C=Rated capacitance in μF.

V=Rated voltage in volts.

8.3.2 *Capacitance* — This test shall be carried out in accordance with **7.3.2** of IS : 7305 (Part 1)-1973* except as modified by **8.3.2.1** and **8.3.2.2**.

8.3.2.1 *Measuring conditions* — Measuring voltage to be applied shall be 0·5 V rms (maximum) or the lower voltage required in order not to exceed the rated ripple current. The frequency of the measuring voltage shall be 100 Hz. A different frequency may be applied provided that the measured capacitance is corrected to a value of 100 Hz. The actual value applied shall be specified in such a case.

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*Specification for fixed capacitors used in electronic equipment : Part 1 General requirements and tests.

8.3.2.2 *Requirement* — The capacitance shall be within the rated tolerance.

8.3.3 *Tangent of Loss Angle* — This test shall be carried out in accordance with **7.3.3** of IS : 7305 (Part 1)-1973* except as modified by **8.3.3.1** and **8.3.3.2**.

8.3.3.1 *Measuring conditions* — Measuring voltage to be applied shall be 0·5 V rms (maximum) or the lower voltage required in order not to exceed the rated ripple current. The frequency of the measuring voltage shall be 100 Hz.

8.3.3.2 *Requirements* — Tangent of loss angle shall not exceed the following values for capacitors with *CV* product $\leqslant$ 100 000 μ Coulomb.

Rated Voltage	*Tangent of Loss Angle*
$U_R \leqslant 4$ V	To be agreed upon between the manufacturer and the purchaser
$4 \text{ V} < U_R \leqslant 10$ V	0·30
$10 \text{ V} < U_R \leqslant 25$ V	0·25
$25 \text{ V} < U_R \leqslant 63$ V	0·20
$63 \text{ V} < U_R$	0·15

For capacitors with *CV* product greater than 100 000 μ Coulomb higher tan δ values may apply as agreed between the purchaser and the manufacturer.

8.3.4 *Impedance* — This test shall be carried out in accordance with **7.3.5** of IS : 7305 (Part 1)-1973* except as modified by **8.3.4.1** to **8.3.4.4**.

8.3.4.1 *Measuring conditions* — The voltage used for the measurement shall be as small as practicable and shall be applied for a time short enough to avoid undue heating of the capacitor. To demonstrate that the voltage is sufficiently small, it shall be applied to one of the capacitors in each sample for 1 minute during which time there shall be no readable change in the impedance of the capacitor.

The error of measurement shall not exceed ±5 percent of the requirement or 0·02 Ω whichever is greater.

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*Specification for fixed capacitors used in electronic equipment : Part 1 General requirements and tests.

8.3.4.2 *Measurement at 25 ± 1°C* — The frequency of the measuring voltage shall be 100 Hz.

8.3.4.3 *Measurement at lower category temperature* — The frequency shall be 100 Hz.

8.3.4.4 *Requirement* — The impedance shall be specified in the form of a ratio as given below:

$$\text{Ratio} = \frac{\text{Value at lower category temperature}}{\text{Value at } 25^\circ\text{C}}$$

The values for this ratio for various rated voltages shall be as follow:

Rated Voltage	*Impedance at*	
	−25/+25°C	−40/+25°C
$U_R \leqslant 6{\cdot}3$	7	12
$6{\cdot}3 < U_R \leqslant 16$	4	9
$16 < U_R \leqslant 160$	3	6

8.3.5 *Insulation Resistance of the Insulating Sleeve (Where Applicable)* — This test shall be carried out in accordance with **7.3.6** of IS : 7305 (Part 1)-1973* except as modified by **8.3.5.1** and **8.3.5.2**.

8.3.5.1 *Measuring conditions* — A metal foil shall be wrapped closely around the full length of the body of the capacitor, protruding by at least 5 mm from each end, provided a minimum space of 1 mm may be maintained between the metal foil and the terminations. The ends of the foil shall not be folded over the ends of the capacitor. If the 1 mm space cannot be maintained, the protrusion of the foil shall be reduced if necessary to establish the 1 mm space. When applicable, the V block method is permitted as an alternative. A direct voltage of 500 ± 50 V shall be applied between the metal foil and the termination connected to the capacitor body, for a minimum period of 1 minute or for the time required to obtain a stable reading. At the end of this period the insulation resistance shall be measured.

8.3.5.2 *Requirement* — The insulation resistance shall be not less than 100 MΩ for general purpose grade and 1 000 MΩfor long life purpose grade.

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*Specification for fixed capacitors used in electronic equipment : Part 1 General requirements and tests.

8.3.6 *Voltage Proof of the Insulation Sleeve* (*Where Applicable*) — This test shall be carried out in accordance with **7.3.1** of IS : 7305 (Part 1)-1973* except as modified by **8.3.6.1** and **8.3.6.2**.

8.3.6.1 *Measuring conditions* — A metal foil shall be wrapped closely around the full length of the capacitor, protruding by at least 5 mm from each end provided a minimum space of 1 mm may be maintained between the metal foil and the terminations. The ends of the foil shall not be folded over the ends of the capacitors. If the 1 mm space cannot be maintained, the protrusion of the foil shall be reduced as may be necessary to establish the 1 mm space. When applicable, the V-block method is permitted as an alternative.

A direct voltage, as given below, shall be applied between the metal foil and the termination connected to the capacitors body:

Long Life Grade — 2 000 V gradually increasing at a rate of 200 V per second; and

General Purpose Grade — 1 000 V gradually increasing at a rate of 100 V per second for capacitors up to rated voltage of 100 V and 2000 V for capacitors above 100 V.

The voltage shall be applied for 1 minute ± 5 seconds.

8.3.6.2 *Requirement* — There shall be no breakdown or flashover during the test.

8.3.7 *Surge Voltage* — This test shall be carried out in accordance with **7.8** of IS : 7305 (Part 1) - 1973* except as modified by **8.3.7.1** to **8.3.7.4**.

8.3.7.1 *Test procedure* — The capacitors shall be subjected to 1 000 cycles, each consisting of charge as described below, followed by a discharge period of 5 minutes 30 seconds through a 1 000 ohm resistor. The ambient temperature shall be upper category temperature for Long Life Grade capacitors and room temperature for General Purpose Grade capacitors.

8.3.7.2 *Charge*

Applied Voltage	1·15× rated voltage for rated voltages $\leqslant$315 V, or 1·10× rated voltage for rated voltages $>$ 315 V.

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*Specification for fixed capacitors used in electronic equipment : Part 1 General requirements and tests.

Internal resistance of the voltage source	As required for R.C. = 0·1 ± 0·05 seconds.
Duration	30 seconds.

8.3.7.3 *Recovery (where applicable)* — The capacitors shall be allowed to cool to standard atmospheric conditions for testing during 1 to 2 hours.

8.3.7.4 *Final measurements and requirements*

Measurement	*Measuring Condition*	*Requirement*
Visual examination	**8.4.1**	No leakage of electrolyte or other visible damage
Leakage current	**8.3.1**	As in **8.3.1**
Capacitance	**8.3.2**	The percentage difference between the capacitances measured finally and in **8.3.2** shall not exceed ±5 percent for Long Life Grade applications and ±10 percent for General Purpose Grade applications
Tangent of loss angle	**8.3.3**	As in **8.3.3**

8.4 Physical and Mechanical Tests

8.4.1 *Visual Examination* — The capacitors shall be visually examined for compliance with the requirements of marking, workmanship and finish.

8.4.2 *Dimensions* — The dimensions shall be checked and shall comply with those specified in **6.1**.

8.4.3 *Robustness of Terminations*— Following tests shall be carried out:

a) *Tensile test* — This test shall be carried out in accordance with IS : 9000 (Part 19/Sec 1)-1978*,

b) *Bending test* — This test shall be carried out in accordance with IS : 9000 (Part 19/Sec 3)-1978*,

c) *Torsion test* — This test shall be carried out in accordance with IS : 9000 (Part 19/Sec 4)-1978*, and

d) *Torsion test on screw terminals* — This test shall be carried out in accordance with IS : 9000 (Part 19/Sec 4)-1978*.

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*Basic environmental testing procedures for electronic and electrical items: Part 19/Sec 1 to 5 Test for robustness of terminations and intergral mounting devices.

8.4.3.1 *Requirements* — There shall be no visible damage after any of these tests.

8.4.4 *Soldering* (*When Applicable*)

8.4.4.1 *Solderability of terminations* — This test shall be carried out in accordance with IS : 9000 (Part 18/Sec 1)-1981* with following modifications:

a) The wire terminations, stated by the manufacturer to be suitable for use with printed wiring shall be immersed up to 2 $^{+0{\cdot}5}_{-0}$ mm from the body with a suitable heat shield, which will simulate a printed wiring board.

b) Where the solder bath method is not appropriate the soldering iron test shall be used with soldering iron of size A.

8.4.4.2 *Resistance to soldering heat* — This test shall be carried out in accordance with IS : 9000 (Part 18/Sec 2)-1981*, with following modifications:

a) *Conditions* — No predrying,

b) For capacitors intended for printed wiring applications the terminations shall be immersed up to 2 $^{+0}_{-0{\cdot}5}$mm from the body with no heat shield, or

c) The terminations shall be immersed up to 6 $^{+0}_{-0{\cdot}5}$ mm from the body and no heat shield shall be used.

8.4.4.3 *Final inspection and measurements and requirements* — shall be as given below:

Inspection or Measurement	*Measuring Condition*	*Requirement*
Visual examination	**8.4.1**	There shall be no visible damage. The marking shall be legible.
Capacitance	**8.3.2**	The percentage difference between the capacitances measured finally and in **8.3.2** shall not exceed ±5 percent.
Leakage current (applicable to Long Life Grade capacitors only)	**8.3.1**	Change in leakage current value shall be within the initial limits.
tan δ	**8.3.3**	Change in tan δ value shall be within initial limits.

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*Basic environmental testing procedures for electronic and electrical items : Part 18/Sec 1 to 3 Solderability test.

8.4.5 *Vibration* — This test shall be carried out in accordance with IS : 9000 (Part 8)-1981* except as modified by **8.4.5.1** to **8.4.5.3.**

8.4.5.1 *Mounting* — For the purpose of this test these capacitors are not intended to be mounted by their leads. They are provided with a supplementary means of mounting such as a tangential bracket or wrap around bands. Mounting fixtures shall be such as to enable the capacitor to be vibrated along the axes for testing. External connections made to the capacitors for power supply and measurements shall add a minimum of mass and place a minimum of restraint on the capacitor.

8.4.5.2 *Conditioning* — The severity shall be as given below:

Category	*Frequency* (Hz)	*Amplitude or Acceleration whichever is the Lowest*	*Duration* (hours)
1A, 1B and 2A	10-2 000	100 m/s²	3×3
2B	10-500	100 m/s²	3×3
3	10-55	100 m/s²	3×2

8.4.5.3 *Measurements and requirements during testing* — During the last half hour of vibration in each direction an electrical measurement shall be made on the capacitors to determine intermittent failure. Detecting equipment shall detect any interruption with a duration of 0·5 milliseconds or greater. There shall be no interruption. Rated voltage shall be applied.

8.4.5.4 *Final inspection, measurements and requirements*

Inspection or Measurement	*Measuring Condition*	*Requirement*
Visual examination	**8.4.1**	There shall be no leakage of electrolyte or other visible damage. The marking shall be legible
Capacitance	**8.3.2**	The percentage difference between the capacitances measured finally here and in **8.3.2** shall not exceed ±5 percent

8.4.6 *Bump* — This test shall be carried out in accordance with IS : 9000 (Part 7/Sec 2) - 1979† except as modified by **8.4.6.1** to **8.4.6.3.**

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*Basic environmental testing procedures for electronic and electrical items: Part 8 Vibration (sinusoidal) test.

†Basic environmental testing procedures for electronic and electrical items: Part 7/Sec 1 to 5 Impact test.

8.4.6.1 *Mounting* — For the purpose of this test these capacitors are not intended to be mounted by their leads. They are provided with a supplementary means of mounting such as a tangential bracket or wrap around bands. Mounting fixtures shall be such as to subject the capacitors to bump in each place. External connections made to the capacitors for power supply and measurements shall add a minimum of mass and place a minimum of restraint on the capacitor.

8.4.6.2 *Conditioning* — Degree of Severity : 1 000 bumps for General Purpose Grade capacitors

4 000 bumps for Long Life Grade capacitors

Acceleration 4 000 m/s^2

8.4.6.3 *Measurements and requirements during testing* — During the last half hour of bump in each direction and electrical measurement shall be made on the capacitors to determine intermittent failures. Detecting equipment shall detect any interruption with a duration of 0·5 milliseconds or greater. There shall be no interruption. Rated voltage shall be applied.

8.4.6.4 *Final inspection, measurements and requirements*

Inspection or Measurement	*Measuring Condition*	*Requirement*
Visual examination	**8.4.1**	There shall be no leakage of electrolyte or other visible damage
Capacitance	**8.3.2**	The percentage difference between the capacitances measured finally and in **8.3.2** shall not exceed ±5 percent

8.4.7 *Shock* — This test shall be carried out in accordance with IS : 9000 (Part 7/Sec 1) - 1979* except as modified by **8.4.7.1** to **8.4.7.3**.

8.4.7.1 *Mounting* — For the purpose of this test these capacitors are not intended to be mounted by their leads. They are provided with a supplementary means of mounting such as a tangential bracket or wrap around bands. Mounting fixtures shall be such as to subject the capacitors to shock in each plane. External connections made to the capacitors for power supply and measurements shall add a minimum of mass and place a minimum of restraint on the capacitor.

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*Basic environmental testing procedures for electronic and electrical items : Part 7/Sec 1 to 5 Impact test.

8.4.7.2 *Conditioning* — The severity shall be as given below:

Category	*Severity*
1A, 1B, 2A and 2B	1 km/s^2
3	500 m/s^2

8.4.7.3 *Measurements and requirements during testing* — During the last half hour of shock in each direction an electrical measurement shall be made on the capacitors to determine intermittent failures. Detecting equipment shall detect any interruption with a duration of 0·5 milliseconds or greater. There shall be no interruption. Rated voltage shall be applied.

8.4.7.4 *Final inspection, measurements and requirements*

Inspection or Measurement	*Measuring Condition*	*Requirement*
Visual examination	**8.4.1**	No leakage of electrolyte and other visible damage
Capacitance	**8.3.2**	The percentage difference between capacitance measured finally and in **8.3.2** shall not exceed ±5 percent

8.4.8 *Pressure Relief (if Required)* — The object of this test is to determine the ability of the means provided for escape of excessive gas developed in the event of a fault without breaking the capacitor and causing damage to the equipment. Capacitors pressure relief shall be tested by applying a direct voltage in the reverse direction as required for a current of 1 to 10 A.

8.4.8.1 *Requirement* — The pressure relief device shall open in such a way that any danger of explosion or fire is avoided.

8.5 Climatic Tests

8.5.1 *Climatic Sequence* — This test shall be carried out in accordance with **7.5.1** of IS : 7305 (Part 1)-1973* except as modified by **8.5.1.1** to **8.5.1.6**.

8.5.1.1 *Initial measurements* — The capacitance shall be measured.

8.5.1.2 *Sealing (applicable for hermetically sealed types only)* — At the end of the climatic sequence, this test shall be carried out in accordance with **7.16.1** of IS : 589-1961* except as modified by **8.5.1.4** to **8.5.1.6**.

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*Specification for fixed capacitors used in electronic and electrical equipment: Part 1 General requirements and tests.

8.5.1.3 *Conditioning* — Method 1 or 2 of **7.16.1** of IS : 589-1961* shall be used or any other suitable method agreed upon between the manufacturer and the purchaser.

8.5.1.4 *Recovery* — The capacitors shall be removed from the liquid, shaken to remove excess liquid, and then kept under standard atmospheric conditions for recovery for minimum 1 hour and maximum 2 hours.

8.5.1.5 *Final inspection, measurements and requirements* — The capacitors shall be inspected and measured and shall meet the following requirements:

Inspection or Measurement	*Measuring Condition*	*Requirement*
Visual examination	**8.4.1**	No leakage of electrolyte or other visible damage
Leakage current	**8.3.1**	As specified in **8.3.1**
Capacitance	**8.3.2**	The percentage difference between the capacitances measured finally and in **8.4.4** or **8.4.6**, as applicable, shall not exceed ±10 percent for Long Life Grade applications and ±20 percent for General Purpose Grade applications
Tangent of loss angle	**8.3.3**	$\leqslant 1{\cdot}2 \times$ limit in **8.3.3**
Insulation resistance (where applicable)	**8.3.5**	10 MΩ for General Purpose Grade and 100 MΩ for Long Life Grade application
Voltage-proof (where applicable)	**8.3.6**	As in **8.3.6**

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

8.5.2 *Damp Heat (Long Term)* — This test shall be carried out in accordance with IS : 9000 (Part 4)-1979*.

8.5.2.1 Throughout the test, rated voltage shall be applied between the terminations of one half of the specimens. Within 15 minutes after removal from the chamber, rated voltage shall be applied to other half for 15 minutes.

8.5.2.2 *Final inspection, measurements and requirements* — The capacitors shall be inspected and measured and shall meet the following requirements:

Inspection or Measurement	*Measuring Condition*	*Requirement*
Visual examination	**8.4.1**	There shall be no leakage of electrolyte or other visible damage. The marking shall be legible
Leakage current	**8.3.1**	As in **8.3.1**
Capacitance	**8.3.2**	The percentage difference between the capacitances measured finally and in **8.3.2** shall not exceed ±10 percent for Long Life Grade applications and ±20 percent for General Purpose Grade applications
Tangent of loss angle	**8.3.3**	$\leqslant$ 1·2 × limit in **8.3.3**

8.5.3 *Rapid Change of Temperature* — This test shall be carried out in accordance with IS : 9000 (Part 14) - 1978† except as modified by **8.5.3.1** and **8.5.3.2**.

8.5.3.1 *Conditioning* — The capacitors shall be subjected to this test for 5 cycles with 15 minutes recovery time between two cycles. The duration of the exposure at each temperature limit shall be 30 minutes or 3 hours.

8.5.3.2 *Recovery* — The recovery period shall be 16 hours.

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*Basic environmental testing procedures for electronic and electrical items : Part 4 Damp heat (steady state).

†Basic environmental testing procedures for electronic and electrical items : Part 14 Change of temperature.

8.5.3.3 *Final inspection, measurements and requirements* — The capacitors shall be inspected and measured and shall meet the following requirements:

Inspection or Measurement	*Measuring Condition*	*Requirement*
Visual examination	8.4.1	There shall be no leakage of electrolyte or other visible damage
Capacitance	8.3.2	The percentage difference between the capacitances measured finally and in **8.3.2** shall not exceed ±5 percent for Long Life Grade applications and +10 percent for General Purpose Grade applications
Leakage current	8.3.1	Change in leakage current value shall be within initial limits
Tangent of loss angle	8.3.3	Change in tan δ value shall be within initial limits

8.5.4 *Mould Growth* — This test shall be carried out in accordance with IS : 9000 (Part 10) - 1979*. There shall be no mould growth visible on the capacitors.

8.5.5 *Salt Mist* — This test shall be carried out in accordance with IS : 9000 (Part 11) - 1983†. There shall be no leakage of electrolyte or other visible damage.

8.5.6 *Resistance to Solvents* — This test shall be carried out in accordance with IS : 9000 (Part 20) - 1979‡ and shall meet the requirements stated therein.

8.6 Characteristics at Low and High Temperature

8.6.1 *Conditions* — The capacitors shall be subjected successively to the procedures of tests as given in **7.1** and **7.2** of IS : 589-1961§ at the appropriate degree of severity.

Basic environmental testing procedures for electronic and electrical items :

*Part 10 Mould growth test.

†Part 11 Salt mist test.

‡Part 20 Resistance to cleaning solvents and performance of markings.

§Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

8.6.2 *Measurements and Requirements* — The capacitors shall be measured at each temperature step and shall meet the requirements as given in **8.6.3**. The measurements shall be carried out at thermal stability which has been reached when no appreciable variation of capacitance has occurred during the preceding 15 minutes.

8.6.3 The following measurements and requirements shall apply:

Step	*Temperature*	*Measurement*	*Measuring Condition*	*Requirement*
1	27 ± 2°C	Capacitance	**8.3.2**	—
		tan δ	**8.3.3**	—
		Impedance	**8.3.4***	—
		Leakage current	**8.3.1**	—
2	Low temperature	Impedance	**8.3.4.3**	The impedance ratio at low temperature shall be measured at 100 Hz. The ratio of the impedances measured at low temperature and at step 1 shall not exceed the values specified in **8.3.4.4**
3	27 ± 2°C	Capacitance	**8.3.2**	—
		tan δ	**8.3.3**	—
		Impedance	**8.3.4**	—
		Leakage current	**8.3.1***	—
4	High temperature	Leakage current	**8.3.1**	⩽ 10 × limit specified in **8.3.1** for capacitors with upper category temperature beyond 85°C ⩽ 5 × limit specified in **8.3.1** for capacitors with upper category temperature of 85°C

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*Measured at the same frequency as used in step 2.

Step	*Temperature*	*Measurement*	*Measuring Condition*	*Requirement*
				⩽ 3 × limit specified in **8.3.1** for capacitors with upper category temperature of 70°C
		Capacitance	**8.3.2**	±20 percent of the initial value for capacitors with upper category temperature of 85°C and above
				±10 percent of the initial value for capacitors with upper category temperature of 70°C
		tan δ	**8.3.3**	⩽ 1·3 × limit specified in **8.3.3** for long life grade capacitors
				⩽ twice the limit specified in **8.3.3** for general purpose grade capacitors
5	27 ± 2°C	Capacitance	**8.3.2**	—
		tan δ	**8.3.3**	—
		Impedance	**8.3.4***	—
		Leakage current	**8.3.1**	—

8.7 Storage

8.7.1 *Storage at Upper Category Temperature*

8.7.1.1 *Conditioning*

Temperature : Upper category temperature
Duration : 96 ± 4 hours

8.7.1.2 *Recovery*

Temperature : Standard ambient temperature
Duration : 16 hours

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*Measured at the same frequency as used in step 2.

8.7.1.3 *Final measurements and requirements* — After the test the capacitors shall meet the following requirements:

Inspection or Measurement	*Measuring Condition*	*Requirement*
Visual examination	**8.4.1**	There shall be no leakage of electrolyte or other visible damage
Leakage current	**8.3.1**	The leakage current shall not exceed twice the limit specified in **8.3.1**
Capacitance	**8.3.2**	The percentage difference between the capacitances measured finally and in **8.3.2** shall not exceed ± 10 percent for Long Life Grade and $^{-20}_{+10}$ percent for General Purpose Grade
Tangent of loss angle	**8.3.3**	The tangent of the loss angle shall not exceed 1·2 times the limit specified in **8.3.3** for Long Life Grade capacitors and 1·5 times the value specified in **8.3.3** for General Purpose Grade capacitors

8.7.2 *Storage at Low Temperature* — This test shall be carried out in accordance with 7.7 of IS : 7305 (Part 1) - 1973* except as modified by **8.7.2.1** to **8.7.2.3**.

8.7.2.1 *Conditioning*

Duration : 72 hours
Temperature : Lower category temperature as specificed in **3.1**

8.7.2.2 *Recovery*

Temperature : Standard ambient temperature
Duration : 16 hours

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*Specification for fixed capacitors used in electronic equipment : Part 1 General requirements and tests.

8.7.2.3 *Final inspection, measurements and requirements* — The capacitors shall be inspected and measured and shall meet the following requirements:

Inspection or Measurement	*Measuring Condition*	*Requirement*
Visual examination	**8.4.1**	There shall be no leakage of electrolyte or other visible damage
Leakage current	**8.3.1**	As in **8.3.1**
Capacitance	**8.3.2**	The percentage difference between the capacitances measured finally and in **8.3.2** shall not exceed ± 10 percent
Tangent of loss angle	**8.8.3**	As in **8.3.3**

8.8 Endurance — This test shall be carried out in accordance with **7.6** of IS : 7305 (Part 1) - 1973* except as modified by **8.8.1** to **8.8.3**.

8.8.1 *Conditioning*

Test duration	2 000 h for Long Life Grade 1 000 h for General Purpose Grade
Ambient temperature	Upper category temperature
Applied voltage	dc at rated voltage

8.8.2 *Recovery*

Duration : 16 hours

8.8.3 *Final Inspection, Measurements and Requirements* — The capacitors shall be inspected and measured and shall meet the following requirements:

Inspection or Measurement	*Measuring Condition*	*Requirement*
Visual examination	**8.4.1**	There shall be no leakage of electrolyte or other visible damage

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*Specification for fixed capacitors used in electronic equipment : Part 1 General requirements and tests.

Inspection or Measurement	*Measuring Condition*	*Requirement*
Leakage current	**8.3.1**	As in **8.3.1**
Capacitance	**8.3.2**	The percentage difference between the capacitance measured finally and in **8.3.2** shall not exceed ±15 percent for Long Life Grade capacitors and ±25 percent for General Purpose Grade capacitors
Tangent of loss angle	**8.3.3**	Long Life Grade : Tan δ shall not exceed 1·3 × the limit in **8.3.3** General Purpose Grade : tan δ shall not exceed twice the limit in **8.3.3**
Impedance	**8.3.4**	Long Life Grade : shall not exceed 2 times the initial specified limit General Purpose Grade : shall not exceed 3 times the initial specified limit

APPENDIX A

(*Clause* 7.2.1)

RECOMMENDED GUIDELINES FOR TAPE PACKAGING OF ALUMINIUM ELECTROLYTIC CAPACITORS WITH AXIAL LEADS

A-1. These guidelines give methods, general dimensions, and preferred tolerances for the taping of capacitors with axial leads. These guidelines give only the lead taping type of packaging and do not indicate the dimensions of the capacitors themselves.

A-2. DIMENSIONS

A-2.1 Lead Taping Type of Packaging — The standard widths of the tape, *a* shall be 6 ± 1 mm and 9 ± 1 mm. The standard spacings between capacitors and the permissible deviations shall be as follows:

Standard Spacings Between Capacitors (*s*) (mm)	*Permissible Deviations Over Ten Spacings* (mm)
5 ± 0·5	±2
10 ± 0·5	±2
15 ± 0·75	±3
20 ± 1·00	±4

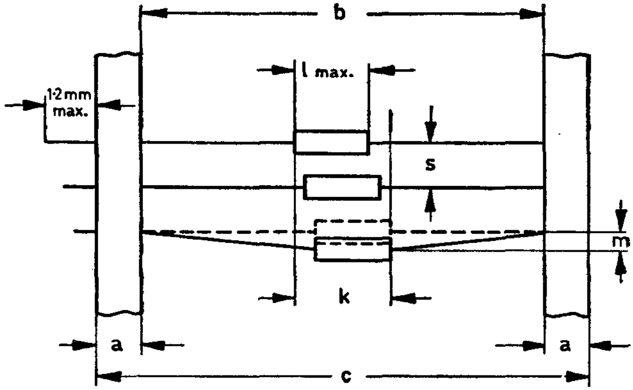


FIG. 1 TAPE PACKAGING OF AXIAL LEAD CAPACITORS

A-2.1.1 *Body Location (Permissible Lateral Deviation)* — Dimension *k*, being the width of the window in which the capacitor body shall be located shall be 1·4 mm wider than the maximum length *l Max* of the capacitor body.

Unless otherwise specified, the window shall be located centrally between the tapes.

A-2.1.2 *Tape Spacing* — The maximum tape spacing *c* shall not exceed 140 mm; its value is chosen in relation to the capacitor dimensions.

NOTE — According to Fig. 1, the inner tape spacing (*b*) is equal to the total length of the capacitor (including the length of the wire leads) from which width of both the tapes and length of the wire protruding beyond the tapes are subtracted.

For certain applications the inner tape spacings of 53±2 mm, 63±2 mm, and 73±2 mm are commonly used. These are based on 6 mm tape width.

A-2.2 Taping — The following requirements for capacitors shall be met (*see* Fig. 1).

A-2.2.1 All polarized capacitors shall be orientated in one direction; the polarized capacitors shall be clearly identified, preferably by the use of dissimilar coloured or marked tapes, the anode being of a white or neutral colour.

A-2.2.2 The following requirements for wire leads shall be met:

a) The wire leads shall be free from kinks and bends.

b) The methods of positioning the capacitors or wires on the tape shall be such that the capacitor leads are not nicked or otherwise damaged.

c) Leads shall not be bent beyond 1·2 mm from their nominal position when measured from the leading edge of the capacitor lead at the inside tape edge and at the lead egress from the component (*see* dimension *m* in Fig. 1).

A-2.2.3 The ends of the leads shall preferably not protrude beyond the tapes.

A-2.2.4 The capacitors shall be held sufficiently in the tape or tapes so that they cannot become free in normal handling.

A-2.2.5 The adhesive and the base of the tapes shall be able to withstand storage of the taped capacitors without danger of migration along the lead wires or the giving off of vapours which make soldering difficult or deteriorate the capacitor properties or lead wires by chemical action (for example, corrosion):

In addition, the adhesive shall not become so detached that the capacitors do not remain in position after storage, and the base material shall not age sufficiently to lose strength such that it breaks on unreeling when the taped capacitors are fed from the package by hand into the assembly machines.

Tapes in adjacent layers shall not stick together in the packing.

A-2.2.6 Splices shall be equal in strength to the original tape and shall be not thicker than four times the thickness of a single layer of original tape. Splices shall not be misaligned by more than 0·8 mm. When splicing is applied, capacitor spacing (s) shall remain within the tolerance as specified in **2.1**.

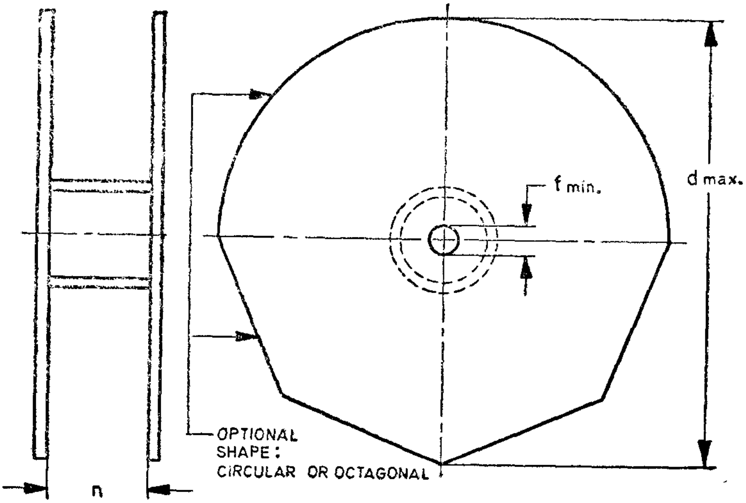
A-2.2.7 A twin leader tape, free of capacitors, having a minimum length of 300 mm shall preferably be provided at the beginning and at the end of the tape.

A-2.2.8 For automatic insertion, it is required that the number of empty places in the tape per reel shall not exceed 0·25 percent without consecutive empty places.

A-3. PACKING

A-3.0 The tapes of capacitors may either be wound on reels or folded, for instance in a concertina arrangement. The unit of packing shall preferably be 100 or multiples thereof.

A-3.1 Dimensions of the Reel — The preferred reel dimensions are shown in Fig. 2.



d max = 400 mm
f min = 14 mm
f max = 25 mm

FIG. 2 REEL FOR TAPE PACKAGING

A-3.2 The distance n between the flanges shall be governed by the overall length of the taped capacitor and shall allow proper reeling and unreeling.

A-3.3 In order to prevent capacitor damage and lead distortion, protection between layers of capacitors and over the last layer may be necessary. Protection capacitors material, if applied, shall not cause deterioration of the capacitor or of lead solderability.

A-3.4 The total number of capacitors on the reel shall be such that the capacitors and the final cover shall not extend beyond the smallest dimension of the flange (in the radial direction).

A-4. MARKING

A-4.0 When required, the number of capacitors shall be marked on one tape at every 50th or 100th capacitor.

APPENDIX B

(*Clause* 7.2.1)

RECOMMENDED GUIDELINES FOR TAPE PACKAGING OF ALUMINIUM ELECTROLYTIC CAPACITORS WITH UNIDIRECTIONAL LEADS

B-1. These guidelines give methods, general dimensions and preferred tolerances for the taping of capacitors with unidirectional leads. These guidelines give only the lead taping type of packaging and do not indicate the dimensions of the capacitors themselves.

B-2. DIMENSIONS

B-2.0 For dimension, *see* Fig. 3.

B-2.1 Tape Width

B-2.1.1 *Carrier Tape Width* W — The carrier tape width W shall be $18 {}^{+1\cdot0}_{-0\cdot5}$ mm.

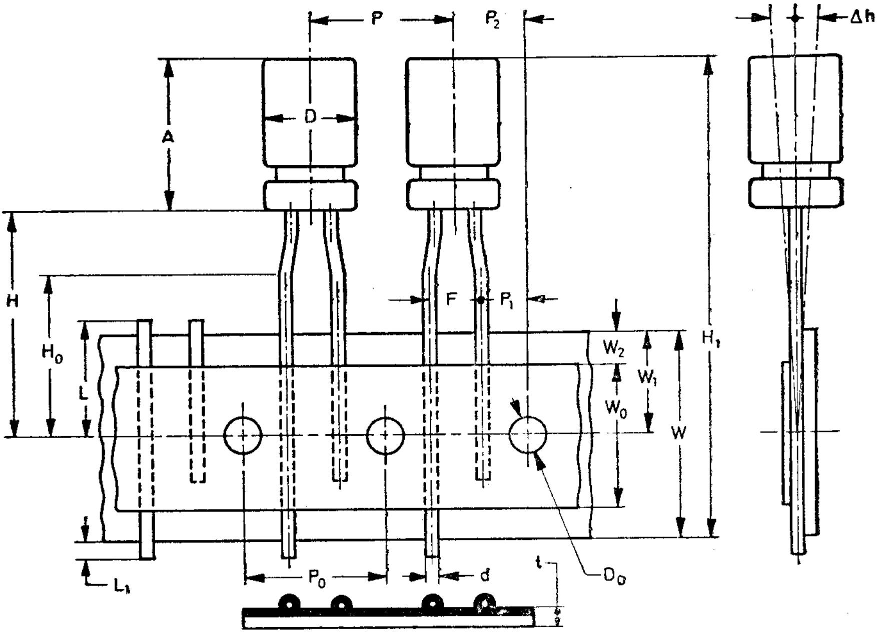


FIG. 3 TAPE PACKAGING OF CAPACITORS WITH UNIDIRECTIONAL LEADS

B-2.1.2 *Hold Down Tape Width W* — This dimension is governed by the retention of the capacitors in the tape. The hold down tape shall not protrude beyond the carrier tape.

B-2.2 Position W_1 of Sprocket Holes — It shall be $9^{+0·75}_{-0·50}$ mm.

B-2.3 Diameter D_0 of the Sprocket Hole — The diameters shall be 4 ± 0·2 mm.

B-2.4 Distance H — The distance between the centre line of the sprocket holes and the bottom plane of the capacitor body (H) shall be $18^{+1\cdot2}_{-0}$ mm.

Note — Dimension H may be influenced by requirements of the individual insertion equipment.

B-2.5 Distance H_0 **(for Crimped Leads only)** — The distance between the centre line of the sprocket holes and the seating plane of capacitors with crimped leads (H_0) shall be 16 ± 0·5 mm.

B-2.6 Distance H_1 — The distance between the centre line of the sprocket holes and the top of the capacitor body (H_1) shall be 32·2 mm maximum.

B-2.7 Lead Diameters d — The lead diameter sizes shall be between 0·5 ± 0·02 mm to 0·8 ± 0·02 mm.

B-2.8 Protrusion of the Ends of the Leads

B-2.8.1 *Protrusion* L_1 — The protrusion beyond the lower side of the carrier tape (L_1) shall be 2 mm maximum.

B-2.8.2 In case of cut-out capacitors the length L of the residual leads beyond the upper tape edge measured from the centre line of the sprocket holes shall be 11 mm maximum.

Note — Any protrusion on either side should be avoided whenever possible.

B-2.9 Pitch P_0 **of the Sprocket Holes** — The positioning of the capacitors shall be symmetrical related to the sprocket holes in the tape. The grid e is defined as $e = 2{\cdot}54$ mm.

B-2.9.1 For capacitor with lead spacings of $1 \times e$, $2 \times e$, $2{\cdot}5 \times e$ and $3 \times e$, the pitch (P_0) shall be 12·7 ± 0·3 mm.

Note — Capacitors with a lead spacing of $3 \times e$ on tapes with a sprocket hole pitch of 12·7 mm may be delivered with the holes arranged between the leads of the capacitor (*see* Fig. 4).

B-2.9.2 For capacitors with lead spacings of $3 \times e$, $4 \times e$, $5 \times e$, $6 \times e$, the pitch (P_0) shall be 25·4 ± 0·3 mm.

Note — For a capacitor pitch of 25·4 mm the holes may optionally be arranged with a hole pitch of 12·7 mm.

B-2.9.3 Pitch tolerance over any 10 pitches shall be ±1 mm.

B-2.10 Thickness t — The total thickness t of the combined carrier and hole-down tape shall be 0·9 mm maximum.

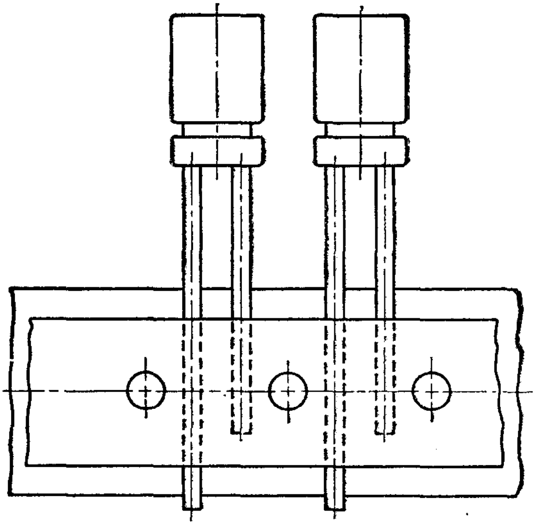


FIG. 4 SPROCKET HOLES FOR CAPACITORS WITH LEAD SPACING OF 3 × *e*

B-2.11 Capacitor Body — Consideration must be taken regarding the shape and dimensions of the capacitor body in relation to the equipment being used.

B-2.12 Deviations — Shall be as given below:

a) maximum lateral deviation △h of the capacitor body vertical to the tape plane	±2 mm
b) maximum deviation of the capacitor body in the reference plane P_1 from the nominal position of 6·35 mm	±1·30 mm
c) maximum deviation of the capacitor leads in the reference plane P_1 from the nominal position of 3·85 mm	±0·70 mm

P_1 is the distance between the ordinate and the first lead of the capacitor (in the direction of unreeling). Nominal values for P_1 and P_0 (*see* Fig. 3) are given in Table 4.

TABLE 4 NOMINAL VALUES OF P_1 AND P_0

(*Clause* B-2.12)

LEAD SPACING *F* (e = 2·54 mm) (1)	P_1 (2) mm	P_0 (3) mm
½ × *e*	5·08	12·7
2 × *e*	3·81	12·7
2·5 × *e*	3·17	12·7
3 × *e*	8·89	25·4
3 × *e* (short leads)*	2·54	12·7
3 × *e* (according to Fig. 1)	3·81	12·7
4 × *e*	7·62	25·4
5 × *e*	6·35	25·4
6 × *e*	5·08	25·4

*When this option is used, care shall be taken that the leads do not interfere with the sprocket holes.

B-2.13 Lead Spacing *F* of Capacitors — *See* Table 3.

B-2.14 Tolerance on Lead Spacing *F* — It shall be $^{+0·8}_{-0·2}$ mm.

B-3. TAPING

B-3.0 The following additional requirements shall be met.

B-3.1 All capacitors shall be oriented in one direction. The cathode lead shall be the first to leave the package. Orientation can be different, if agreed to between the manufacturer and the user.

B-3.2 The wire leads of the taped capacitors shall be free from kinks from the seating plane downwards to the carrier tape.

B-3.3 The capacitors shall be held sufficiently in the tape, so that their position remains within the permitted tolerances.

The extraction force for components in the tape plane, vertically to the direction of unreeling shall be greater than or equal to 2N.

B-3.4 The tapes shall be suitable to withstand storage of the taped capacitors without danger of migration along the lead wires or giving off vapours, which would make soldering difficult or deteriorate the capacitor properties or lead wires by chemical action (for example corrosion).

In addition, the adhesive shall not become detached in such a way that the capacitors do not remain in position after storage and the carrier tape material shall not age and therefore lose strength such that it breaks on unreeling when the taped capacitors are fed from the package by hand into the assembly machines.

Tapes in adjacent layers shall not stick together in the packing. The sprocket holes shall be free from burrs and traces of adhesive from the hold-down tape.

B-3.5 Break Force of the Tape — It shall be greater than or equal to 15N.

B-3.6 Splices — Splices shall be equal in strength to the original tape and shall not hamper the transport and the cutting of the tape. When splicing is applied the misalignment of the holes at each side of the splice shall not be more than 0·3 mm in any direction. Splices shall not interfere with sprocket feed holes nor shall the overall thickness exceed 1·5 mm. Staples may be used but shall not interfere with the transport and cutting operations.

B-3.7 For tapes in concertina arrangement the hold-down tape shall not become separated in the region of the fold. If this cannot be avoided, the value of the maximum tape thickness shall not be excedeed.

B-4. PACKING

B-4.0 The tapes of capacitors, may either be wound on reels, wound in a cassette or folded (for example, in a concertina arrangement). The unit of packing shall preferably be 100 or multiples thereof. When winding the tape on the reel or cassette, the carrier tape shall be closest to the centre of the reel or cassette.

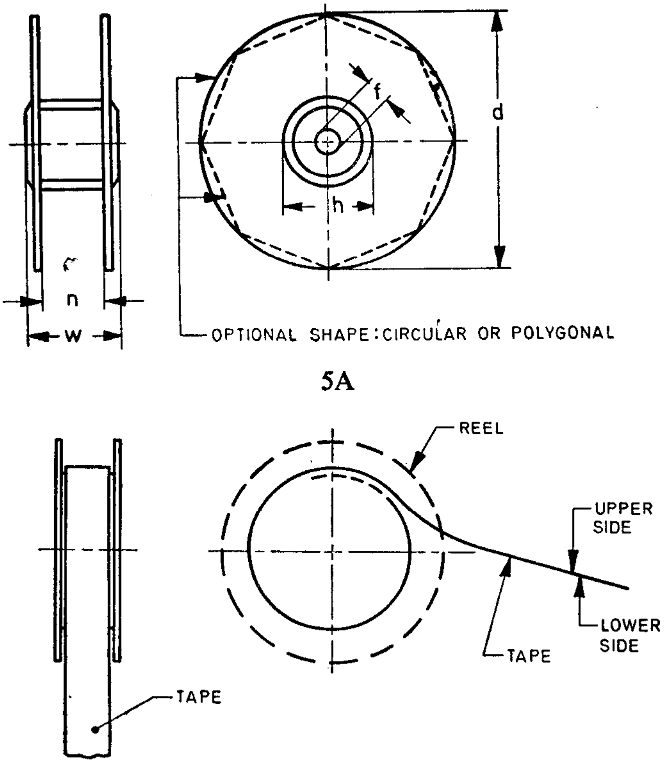
B-4.1 Dimensions of the Reel

B-4.1.1 The preferred reel dimensions are shown in Fig. 5.

B-4.1.2 The distance *n* between the flanges shall be governed by the overall dimensions of the taped capacitor and shall allow for proper reeling and unreeling.

B-4.1.3 In order to prevent capacitor damage and lead distortion, protection between layers of components and over the last layer may be necessary. Protection material, if applied, shall not cause deterioration of the capacitor or of lead solderability.

B-4.1.4 The total number of capacitors on the reel shall be such that the capacitors and the final cover shall not extend beyond the smallest dimensions of the flange in the radial direction.



w = 55 mm, max.
d = 400 mm, max.
f = 14 mm, min.
31 mm, max.
h = 80 mm, min.

5A

5B

FIG. 5 REEL FOR TAPE PACKAGING

B-4.2 Dimensions of the Box for Concertina (Ammo) Packing — It shall be 340 × 340 mm maximum.

NOTE — The thickness of the box shall be governed by the overall width of the taped capacitors.

B-4.3 Missing Capacitor — A maximum of 3 consecutive capacitors may be missing provided this gap is followed by 6 consecutive capacitors.

A maximum of 0·5 percent of the total number of the capacitors per reel may be missing.

B-5. MARKING

B-5.0 When required the tape shall be marked at every 50th or 100th capacitor place.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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